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VENTURE CAPITAL INVESTMENTS UNDER FINANCING CONSTRAINTS: EVIDENCE FROM THE 2020 PANDEMIC CRISIS

NICCOLO' ALLIEVI

Work project carried out under the supervision of:

Margarida Soares

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Abstract

This paper employs the 2020 pandemic crisis as an empirical setting to analyze how venture capitalists investments react under financing constraints. In particular, this paper examines how the amount per round received by a startup from venture capital funds is affected by the COVID-19 outbreak and if there are particular sectors that are benefitting from the situation. The empirical findings show that in 2020 the average amount per round raised is higher than it was in the past years and that VCs have preferred to invest more money for younger new ventures belonging to Information Technology and Medical/Health/Life Science sectors.

Keywords: Venture capital, Startup, Entrepreneurial Finance, Covid-19 crisis, Investment

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1. Introduction

By funding new ventures, venture capitalists (VCs) help alleviate asymmetry problems associated with new founded startups (Gompers and Lerner, 2001). Indeed, VCs invest both their financial and non-financial capital addressing these market frictions by the *ex-ante* screening and *ex post* monitoring of companies. By overcoming these market failures, VCs make their contribution to employment growth, innovation and higher aggregate income (Kortum and Lerner, 2000; Samila and Sorenson, 2010, 2011; Colombo et al., 2016).

Generally, there are several factors which might affect VCs investment strategies in a startup: the total amount of funding already received, the number of patents granted, the startup sector, the number of investment rounds, the geography of the new ventures, the age at financing, are all examples of variables which might influence the VCs investment decisions. Despite these factors, little is known about how VC investment model reacts under sudden and severe stress. Financial crises introduce shocks that alter the economic environment (Bernanke, 1983), modifying the conditions that support the VC investment model. The Covid-19 outbreak is leading to a triple economic shock: a demand-side shock (whole populations put into quarantine in every major economy, causing a massive reduction of all consumer services), a supply-side shock (the measures imposed by governments to contain the spread of the virus caused severe temporary supply-side restrictions) and a financial shock (most of the governments and central banks are injecting liquidity in the markets, suggesting signs of a liquidity crunch). This three-sides economic shock is likely to reduce VCs' chances to attract syndication partners, raise funds, and successfully exit from previous investments in an environment characterized by weakened acquisition markets and IPO (Nanda and Rhodes-Kropf, 2017; Townsend, 2015).

The aim of this paper is to evaluate how VCs is responding and will respond to Covid-19 financial crisis, with a focus on the effects this crisis has on VCs' portfolio allocations. The research questions are: Does Covid-19 financial shock affect the financing amount VCs invest in startups? Is there a particular sector where VCs are investing in order to alleviate the pandemic associated risk? Which are the other main factors that influence VCs investment decisions?

The unexpected arrival of the COVID-19 pandemic has dramatically affected many aspects of the global economy, and many economic agents are worried that this shock will drastically reduce venture capital flow. In order to better understand and quantify the impact that the pandemic is having and will have on VCs investment model, this paper will statistically analyze the differences between the investments made by VCs during the current year with the ones made in the previous 5 years. Since we are still in the heart of the pandemic is difficult to perfectly forecast how much and how VCs investments will be affected by the crisis, therefore the paper will qualitatively examine the behavior of VCs during the past recession to better predict the effects of the Covid-19 crisis on investments. According to W.Gornall (2020), during the first half of 2020, VCs investment pace is 71% of their normal activity and is expected to be 81% of their normal pace for the rest of the year. As shown by Howell et al. (2020) this pace is similar to the ones of the past recessions, although the extent of the fall is expected to be lower than during the dotcom crisis and the Great Recession, when investments declined respectively by 50% and 30%.

By investigating the repercussions of the pandemic on VCs investment strategy, this paper integrates the literature on how the pandemic uncertainty is impacting VCs and startups (Gompers et al., 2020) with studies on how the financing environment might influence VC strategies (Kerr and Nanda, 2009; Townsend, 2015) and with empirical evidence on the effects that 2008 financial crisis had on VCs strategies (A. Conti et al., 2016). In particular, it sheds light on whether the

pandemic has affected the financing amount VCs are investing in startups and if there are particular sectors in which they are investing in order to alleviate the crisis associated risk.

Overall, this paper helps to conclude that VC industry has been more resilient than most of the other economic sectors. Although Covid-19 is not yet over, the evidence suggests that the impact of the pandemic on VCs has not been significant. These findings represent great news for the development of high-growth companies and the whole innovation ecosystem.

The empirical analysis is based on data for VCs investments in start-ups retrieved from Thomson Reuters Eikon database integrated with a survey of 1,000 VCs on how the pandemic is affecting their investments decisions.

The rest of the paper is structured as follows. In Section 2, it reviews the literature on how the pandemic uncertainty is impacting VCs and startups merged with the literature on how the financing environment affects VCs strategies. In Section 3, it presents the dataset providing descriptive statistics of the sample. Section 4 outlines the hypothesis this paper aims to test and Section 5 the adopted methodology. Section 6 is dedicated to the presentation of the results and comments. Section 7 discusses VC's perspectives for the future. Section 8 concludes the paper.

2. Literature review

For the topic debated in this paper, several strands of literature, both theoretical researches and empirical evidence, are relevant. The literature suggests that, during normal times, there are fundamentally three different Venture Capital strategies: Adding value, Sourcing better and Investing better. Generally, the best fund pursues all of them (Arnold, 2019). Adding value increases the return for VCs on an investment, it is most of the time necessary because the startup founders usually need to be coached and helped in some business areas, such as sales, operations,

partnership, marketing, recruitment etc. By coaching and monitoring the founders and their teams, VC funds help to build the company and create value (Bernstein *et al.*, 2015). Sourcing better represents the strategy based on screening, one of the VCs' main skills. This strategy allows VC funds to target exceptional founders and startups, therefore higher expected returns. By using a mathematical predictive approach to source better, VCs can proactively build selective and high-quality networks of startups from which they can choose, fishing in a better pond can make the difference (Arnold,2019). Investing better means picking better, having good judgement, predicting the future economic trends and innovative technologies. In order to invest better, it is essential for VC funds to develop insights and to do researches which will enable them to choose and structure safer bets.

The previously mentioned VCs strategies are the ones suggested by Paul Arnold founder of Switch Ventures, a seed-stage venture capital firm, during normal times. But what if there is a global crisis and VCs and startups are facing financing constraints? VCs would base their investment decisions on which of the above-mentioned strategies? Would they invest their non-financial capital more in the screening, the monitoring or the picking of startups? Would startups factors, such as number of rounds, funding to date and age at financing, be significant for VCs investment decisions? The literature suggests that startups, since they are young and innovative, are usually characterized by unstable cash flows and/or lack of tangible assets, which means high volatility, thus high risk (Hall, 2002; O'Sullivan, 2005). These characteristics of startups create information asymmetries between VC funds and the firms, thus moral hazard and adverse selection problems, which in turn generate a mismatch between the supply and demand of finance capital for these innovative and risky new ventures (Brown, Fazzari, & Petersen, 2009; Carpenter &

Petersen, 2002; Kerr et al., 2011; Leland & Pyle, 1977; Peneder, 2008). In order to reduce this risk, VCs tend to invest in projects characterized by a lower volatility of cash flows.

If this trend is true during normal times, what happens when the financing environment is affected by uncertainties caused by a financial crisis? Would the VCs under financing constraints focus their investment on less innovative but less risky startups or they would use more the 'investing better' strategy to find the new unicorns? According to Nanda and Rhodes-Kropf (2013), the increased uncertainty during financial crises induces VCs to invest in less innovative projects. Therefore, financing constraints caused by crises can limit innovation and firm growth, although are periods in which innovation should be the key to foster the economic recovery. In particular, according to Sørensen (2007), during cold markets experienced VCs can leverage on their screening and monitoring skills, which have the tendency to be sector-specific (Gompers and Lerner, 2004). Hence, they are likely to focus the available capital in their core sector, deriving higher marginal benefits if compared with a diversified portfolio allocation. Less-experienced VCs, on the other hand, cannot leverage on their monitoring and screening skills, thus they are more likely to hold a diversified portfolio or they can try to find new unicorns by predicting the future economic trends and innovative technologies (much riskier). Empirical findings by A. Conti, Dass and Graham (2017) confirm that, during the Great Recessions, VC funds made smaller and fewer investments reducing their portfolio size. Moreover, their results suggest that information problems and financing constraints have driven experienced VCs to allocate their capital and non-capital resources to new ventures within their core sectors. These findings are particularly true for early stage startups, due to their more accentuated information problems. Less-experienced VCs, instead, held a diversified portfolio across different sectors. These findings are consistent with the above-mentioned literature which emphasizes the difference between

experienced VCs and less-experienced ones in addressing asymmetric information problems and the disadvantage that the latter have on the former in the screening and monitoring skills.

Now that the VCs' behaviour under financing constraints is better defined, we can focus on the aim of this paper: How is COVID-19 impacting VCs investments? Are VC funds changing their strategies to address the pandemic? Are there particular 'safe' sectors in which they are investing? In order to answer these questions, this paper integrates the literature on how the pandemic uncertainty is impacting VCs and startups. According to a survey of 1,000 VCs (Gompers et al., 2020), the impact of the pandemic on the sector will be more moderate than in the dotcom bubble of 2001 and the financial crisis of 2007-2009. VC funds expect to have an investments pace of 81% of their normal pace, nothing compared with the past recessions when investments declined by 50% (2001) and 30% (2009). Regarding their portfolio companies, VCs report that 52% of them are not affected or positively affected by the pandemic, 38% are negatively influenced and 10% are in critical condition. Consistent with this, the average fund internal rates of return (IRRs) decreased by 1.6% and the average cash-on-cash returns (MOICs) decreased by 0.07 (GGKS, 2020). The survey shows optimism among VC funds about the performance of their industry, indeed 75% of the funds believe that they will outperform public markets. These evidences can be explained by four main factors. First, the investment terms are more investor friendly than usual, this is possible because the governments are encouraging investments in order to address the pandemic crisis. Second, VC-backed companies are usually flexible, thus they are more able to pivot to smart working (Ding, Levine, Lin, and Xie, 2020) and they usually have little debt and large cash reserves (Papanikolaou and Schmidt, 2020). Third, volatile environments can lead VCs' portfolios to gain value. If the companies within the portfolio are real options on innovative technologies, a higher standard deviation may increase the value of those options, which in turn

will increase the portfolio's value (Fluck, Garrison, and Myers, 2006; Peters, 2018). Last, the systematic risk of the VC industry is much lower than it was in the past recessions, this is consistent with the current better performances of VCs compared to the dotcom crash and the global financial crisis.

3. Data

3.1 Sample construction

In order to examine VC investment strategies under financing constraints, we focus on the crisis caused by the pandemic and draw data on VCs, startups, and financing rounds retrieved from the Thomson Reuters Eikon database. To build the sample that I use in my analyses, I employ data collected by TRE in November 2020.

The analyses begin with a population of 30,253 investments made in the range of year 2015-2020 (inclusive) by VCs in U.S. startups that are listed in the 2020 TRE database. I retain 16,073 investments, for which TRE has data on startups founding years, funding rounds, equity amount invested, and total funding received by the startups prior to the date of the investment taken into account. Choosing this sample period allows me to analyze VCs investment strategies in the years before and during the pandemic. Unfortunately, since COVID-19 has not yet run its course, it is difficult to evaluate its final impact on VCs' portfolio performance, but this paper can explain the effect that it had after the first year of its establishment.

I remove investments made in startups that have corporate venture capital (CVC) as lead investors, in order to focus my analysis exclusively on independent VCs strategies. I also exclude investments made in startups founded before 2000, because they cannot be considered anymore as

"startups". The final sample includes 12,555 VCs investments made in 9,876 different startups over the period 2015Q1-2020Q4.

3.2 Descriptive statistics

As shown in **Table 1**, the startups in the sample are distributed across three main industry classes: information technology (68%), medical/health/life-science (22%), non-high technology (10%). The average age of these startups, as of 2020, is 7.47 years and 51% of them are located in Massachusetts (13%) or California (38%). 16% of the startups in the sample have been financed at least once during 2020, year that this paper considers in order to analyze and measure the impact of the pandemic crisis on the VC industry.

Table 1
Characteristics of sample startups (N=9.876)

	Mean
Information Technology	0,68
Medical/Health/Life Science	0,22
Non-High Technology	0,10
Located in California	0,38
Located in Massachusetts	0,13
Startup was financed at least once during 2020	0,16
Startup age, by 2020	7,47

Table 2 is divided in two different Panels. Panel A shows the characteristics of the total startup financing rounds. Panel B, instead, compares the characteristics of startup financing rounds during normal times with the ones during COVID-19 crisis. As shown in Panel A of **Table 2**, the average amount per round that the startups in the sample received in the range of years 2015-2020 is $22.18 million, with a median of $10 million, which means that the distribution in not symmetric and few startups received the largest amounts. The averages of the startup age and the number of funds at

round r, are respectively 5.8 (years) and 3.95. The startups in the sample raised, on average, $93.91 million within 3.83 rounds prior to round r.

Table 2
Characteristics of startup financing rounds

Panel A	Total rounds (N=12.555)		
	Mean	Median	SD
Round amount in Information Technology ($m)	20,52	9,50	47,37
Round amount in Medical/Health/Life Science ($m)	21,50	12,00	29,82
Round amount in Non-High Technology ($m)	35,03	10,00	121,12
Startup age at round r (years)	5,80	3,75	4,32
No of funds at investment date	3,95	3,00	2,80
Round amount ($m)	22,18	10,00	56,63
Cumulative funding prior to round r ($m)	93,91	37,50	291,73
Number of funding rounds raised at round r	3,83	3,00	3,32

Panel B	Rounds in normal times (N=10.538)			Rounds during COVID-19 crisis (N=2.017)		
	Mean	Median	SD	Mean	Median	SD
Round amount in Information Technology ($m)	19,30	8,30	46,95	26,67	13,55	49,01
Round amount in Medical/Health/Life Science ($m)	20,08	11,00	28,85	29,12	20,00	33,60
Round amount in Non-High Technology ($m)	30,97	10,00	75,13	60,59	12,00	266,67
Startup age at round r (years)	5,60	3,58	4,26	6,81	4,75	4,48
No of funds at investment date	3,89	3,00	2,78	4,23	4,00	2,88
Round amount ($m)	20,67	9,04	47,62	30,09	14,00	89,68
Cumulative funding prior to round r ($m)	94,73	37,91	296,39	89,62	34,90	266,09
Number of funding rounds raised at round r	3,71	3,00	3,28	4,43	3,00	3,49

As Panel B of **Table 2** reports, the average amount per round that startups received during the 2020 is $30.09 million compared to $20.67 million during normal times. This means that VCs invested, on average, $9.42 million more during the pandemic crisis than in the previous 5 years, although, as we will see in **Fig.1**, the number of deals decreased in 2020, meaning that VCs preferred to focus their funds on less but safer projects. This is consistent with a large increase of the average amount invested in Non-High Technology startups (almost doubled) and an increase of the average startup age at round r (5.6 vs 6.81 years). Nevertheless, if we compare the two years before the pandemic outbreak (2018 and 2019) with 2020, we can see that the difference between the average amount invested per round is smaller ($28.76 vs $30.09 million). This evidence reveals that the results in 2020 are in line with the positive trend showed by this variable over the period 2015-2019.

Fig.1 plots the aggregate amount invested in US startups and the number of deals closed by VCs from 2015 to 2020. The graph is based on the data retrieved from the Thomson Reuters Eikon database. As mentioned above, both the number of deals and the total amount of funding invested decreased in 2020. Indeed, in 2019 the amount of equity invested by US VCs in startups was around $74.96 billion with 2,972 closed deals, while in 2020 the dataset records 2,017 deals for a total amount invested of $60.69 billion. Nevertheless, the average amount invested per round is higher than in 2019 and the total is about 147% of the one recorded in 2017, following an increasing trend, as it can be clearly seen from the trendline in the graph. Moreover, the drop in the aggregate amount invested has not been dramatic. Indeed, in 2020 US VCs invested around 80.9% of the funding they invested in 2019, nothing compared with the past recessions, 2001 and 2009, when investments declined respectively by 50% and 30% (Gompers et al., 2020).

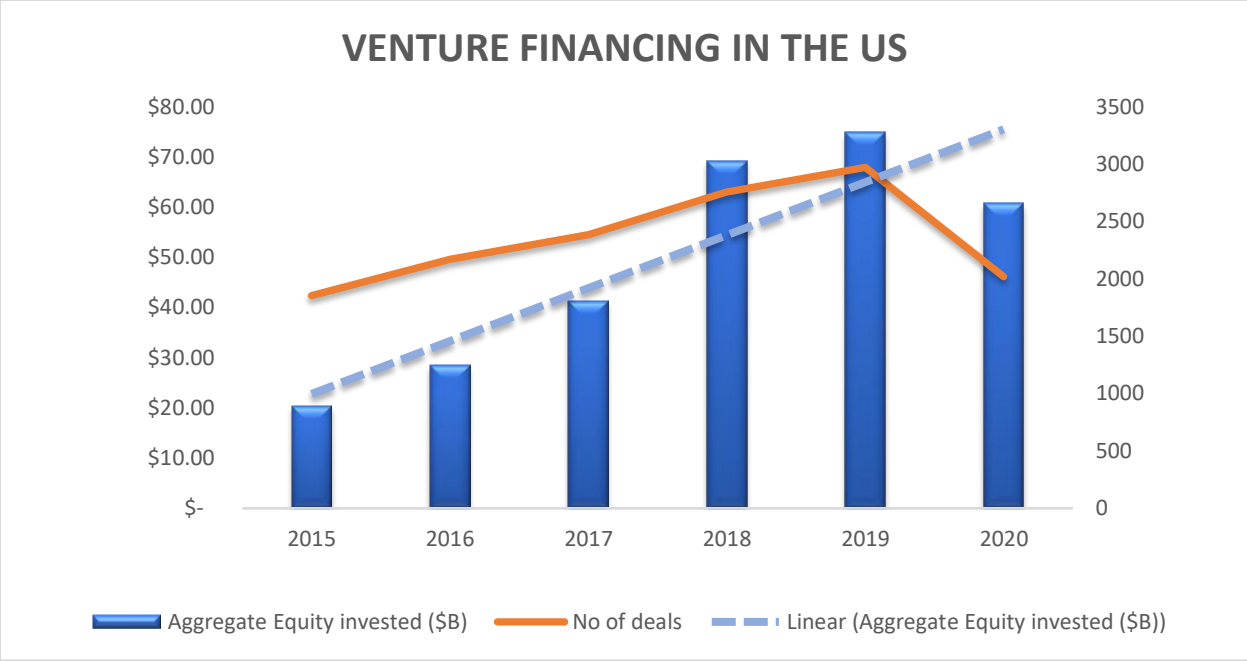

Fig. 1. Venture capital investments in US startups, 2015-2020. This figure reports aggregate funding invested in US startups and the number of closed deals by VCs, collected from the Thomson Reuters Eikon database.

Figs.2a and **2b** show venture financing by three main industry classes in the US respectively for number of closed deals and for amount invested in the period 2015-2020. As we can see, there are not wide variations in both the number of closed deals and amount invested across the sectors over the period considered, with Information Technology leading, followed by Medical/Health/Life Science and Non-High Technology. One fact we can state, is that in 2020, compared to 2019, the percentage of the amount invested in Non-High Technology startups increased by 3%, although the number of closed deals for the category decreased by 1%. Information Technology startups, on the other hand, received (on percentage) less funds than in 2019, but the number of closed deals increased by 2%. This might suggest that during times characterized by higher volatility, VCs would rather invest more money in less innovative projects or closing more deals, but with smaller amounts invested, in more innovative ideas in order to better differentiate their risk.

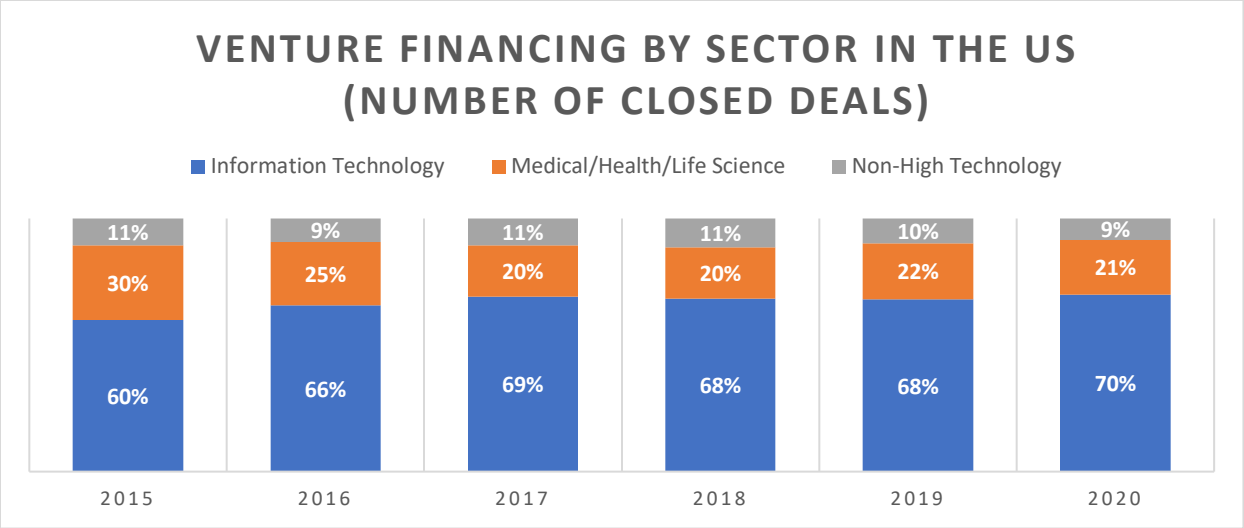

Fig.2a Venture financing by sector in the US for number of closed deals, 2015-2020. This graph reports venture financing by three main industry classes in the US for number of closed deals collected from the Thomson Reuters Eikon database.

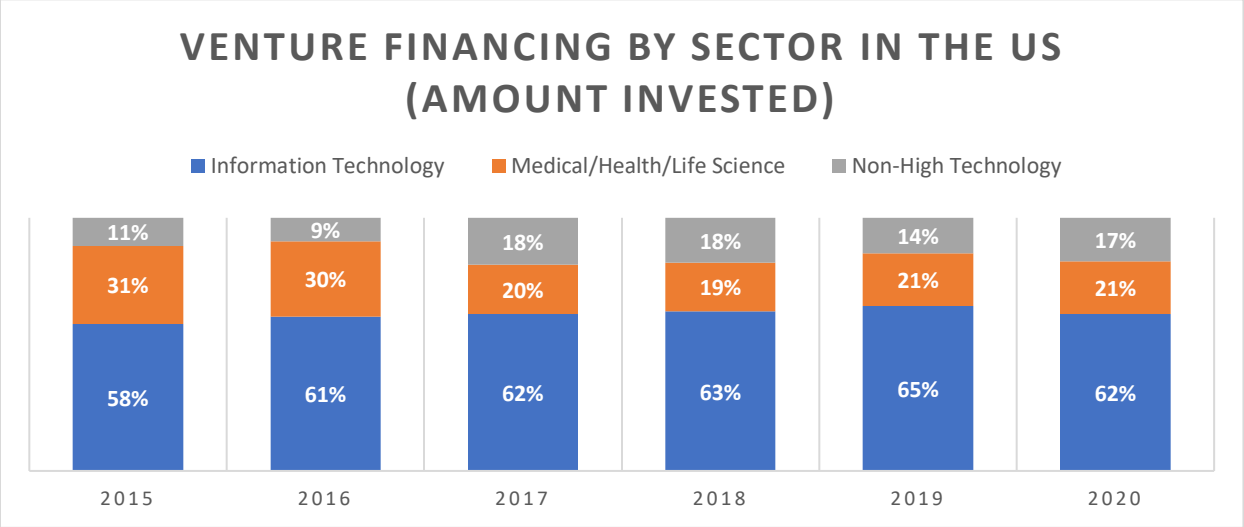

Fig.2b Venture financing by sector in the US for amount invested, 2015-2020. This graph reports venture financing by three main industry classes in the US for amount invested, collected from the Thomson Reuters Eikon database.

4. Hypothesis

The empirical analysis is devoted to study the impact of COVID-19 on VCs investments. In particular, the analysis aims to test three hypotheses. The first hypothesis tested is whether or not the pandemic is affecting the amount per round invested by VCs in US startups. The second hypothesis this paper aims to test is whether VCs are investing in safer or in more innovative, but

riskier, projects. The last hypothesis examined is whether the pandemic has a differentiated impact in different industries, and if there is a particular industry class in which VCs are investing more money than they use to do during normal times.

I have no strong ex ante expectations for the effect of the pandemic on the per round amount, since, as mentioned in the literature review, the systematic risk of the VC industry is much lower than it was in the past recessions and 75% of the funds believe that they will outperform public markets (Gompers et al., 2020). For the second hypothesis I expect, from one hand, that VCs have invested in safer projects to reduce their risk exposure, from the other hand, that they have preferred to invest in more innovative projects which are more able to deal with pandemic environment. Lastly, I expect that, during the pandemic, funds have invested more in the High-Tech and in the healthcare sectors.

5. Methodology

In order to test the above-mentioned hypothesis, I estimate five different equations, one to study the direct impact of the pandemic on the invested funding per round, one to analyze the second hypothesis and the other three to examine if each of the three startups industry classes displayed in Thomson Reuters Eikon database (Information Technology, Medical/Health/Life Science and Non-High Technology) is attracting more or less funds during the crisis.

Several possible variables can be used to measure the amount per round, but the most widely used, according to A.Conti (2017), are the startup age at financing ($Age_{j,r}$) and the investment round number in which the startup is into ($Round\_Number_{j,r}$). In order to better measure the dependent variable, $Round\_Amount_{j,r}$, my analysis add the following variables (which will be

better explained in **Table 3**): $Funding\_to\_Date_{j,r}$, N_Funds_r and a dummy variable named $Covid\_Crisis_r$. Therefore, Equation **(1)** is:

$$Round\_Amount_{j,r} = \alpha + \beta_1 N\_Funds_r + \beta_2 Round\_Number_{j,r} + \beta_3 Age_{j,r} + \beta_4 Funding\_to\_Date_{j,r} + \beta_5 Covid\_Crisis_r + \varepsilon_{j,r} \quad (1)$$

After estimating the baseline effect of the pandemic crisis on the amount that startups raise per round, the analysis follows by testing whether or not VCs are investing more funding in safer projects. In order to do so, I add to Eq.**(1)** an interaction between the variable $Age_{j,r}$ and the dummy $Covid\_Crisis_r$, because I think that older startups could be considered safer as opposite to the younger ones.

$$Round\_Amount_{j,r} = \alpha + \beta_1 N\_Funds_r + \beta_2 Round\_Number_{j,r} + \beta_3 Age_{j,r} + \beta_4 Funding\_to\_Date_{j,r} + \beta_5 Covid\_Crisis_r + \beta_6 Age_{j,r} \times Covid\_Crisis_r + \varepsilon_{j,r} \quad (2)$$

Lastly, I examine if VCs, during cold markets, tend to invest in sectors characterized by a low volatility of cash flows or in innovative sectors trying to predict the future (or current) trends. In order to do so, I estimate three different equations which add to Eq. **(1)** a dummy variable representing the startup industry class (Information Technology, Medical/Health/Life Science or Non-High Technology) and an interaction between this sector specific variable and $Covid\_Crisis_r$. By doing so, we can better understand how the startup sector generally affects $Round\_Amount_{j,r}$ and how it is affecting VCs investments now that we are in the heart of the pandemic. Therefore, the models estimated are:

$$Round\_Amount_{j,r} = \alpha + \beta_1 N\_Funds_r + \beta_2 Round\_Number_{j,r} + \beta_3 Age_{j,r} + \beta_4 Funding\_to\_Date_{j,r} + \beta_5 Covid\_Crisis_r + \beta_6 IT_{j,r} + \beta_7 IT_{j,r} \times Covid\_Crisis_r + \varepsilon_{j,r} \quad (3)$$

and:

$$Round\_Amount_{j,r} = \alpha + \beta_1 N\_Funds_r + \beta_2 Round\_Number_{j,r} + \beta_3 Age_{j,r} + \beta_4 Funding\_to\_Date_{j,r} + \beta_5 Covid\_Crisis_r + \beta_6 NHT_{j,r} + \beta_7 NHT_{j,r} \times Covid\_Crisis_r + \varepsilon_{j,r} \quad (4)$$

and:

$$Round\_Amount_{j,r} = \alpha + \beta_1 N\_Funds_r + \beta_2 Round\_Number_{j,r} + \beta_3 Age_{j,r} + \beta_4 Funding\_to\_Date_{j,r} + \beta_5 Covid\_Crisis_r + \beta_6 MHL_{j,r} + \beta_7 MHL_{j,r} \; x \; Covid\_Crisis_r + \varepsilon_{j,r} \quad (5)$$

Table 3 Variable definitions

Name	Definition
$Round\_Amount_{j,r}$	Natural logarithm of the funding amount received by startup j at round r
N_Funds_r	Number of funds participating in round r
$Age_{j,r}$	Startup j age at round r
$Round\_Number_{j,r}$	Investment round number r in which startup j is participating
$Funding\_to\_Date_{j,r}$	Natural logarithm of the total funding received by startup j from its foundation to round r
$Covid\_Crisis_r$	Dichotomous variable that takes the value of one for innovative start-up firms, and zero otherwise
$IT_{j,r}$	Dichotomous variable that takes the value of one if startup j, that receives funds in round r, belongs to Information Technology industry class, and zero otherwise
$NHT_{j,r}$	Dichotomous variable that takes the value of one if startup j, that receives funds in round r, belongs to Non-High Technology industry class, and zero otherwise
$MHL_{j,r}$	Dichotomous variable that takes the value of one if startup j, that receives funds in round r, belongs to Medical/Health/Life Science industry class, and zero otherwise

The coefficients of particular interest in this paper are the dummy $Covid\_Crisis_r$, the interaction between the variable $Age_{j,r}$ and the dummy $Covid\_Crisis_r$, the coefficients on the dummies representing the different industry classes, and their interaction with the dummy $Covid\_Crisis_r$.

6. Results

Table 4 reports the results for two different specifications of Equation **(1)**. Column (I) reports the results for a basic specification in which startup per round amount depends on the number of funds at investment date, the round number, the startup age at financing, the natural logarithm of the total funding received by the startup and a dummy indicating whether or not the investment was made during the Covid crisis. In column (II) it is included the nonlinear effect of age on the round amount.

Table 4 shows that the number of funds participating in an investment round and the total funding received by a startup have a positive impact on the round amount. Indeed, if the number of funds increases by one, the per round amount increases by $1*e^{0,1245}$ and for a 1% increase in total funding, it increases by about 0.75%. These findings are consistent with the common logic, if there are more investors, the likelihood of raising more funding is higher, and if a startup has received more funds in the past, VCs are more likely to invest a higher amount, since it might be a signal of the company potential and reliability. The regression finds that age at financing has a non-monotonic effect on round amount, in fact older firms receive more, but the opposite happens

Table 4
Covid crisis and startup per round amount

	Startup round amount (log)	
	(I)	(II)
Number of funds	0,1245***	0,1235***
	(0,0030)	(0,0030)
Round number	-0,0798	-0,0826
	(0,0032)	(0,0032)
Age at financing	0,0374***	0,1314***
	(0,0024)	(0,0070)
Age at financing^2		-0,0059***
		(0,0004)
Total funding to date (log)	0,7473***	0,7436***
	(0,0065)	(0,0064)
Covid Crisis	0,4271	0,4150
	(0,0219)	(0,0218)
Intercept	2,5163***	2,3590***
	(0,1066)	(0,1063)
Multiple R	0,7874	0,7913
R-squared	0,6201	0,6262
Adjusted R-squared	0,6199	0,6260
Standard Error	0,8933	0,8862
Observations	12555	12555

Table 4 presents OLS regression results for the amount of investment funds that a startup raised in a given round. Columns I and II report the coefficients for two different specifications of Equation **(1).** Each observation corresponds to a round *r* raised by a startup *j*. In columns I are reported the results for the basic Eq.**(1)**, column II includes the nonlinear effect of age on the round amount. The definitions of all the variables are provided in **Table 3**. The standard errors are in parentheses. Significance noted as: *p < 0.10; **p < 0.05; ***p < 0.01.

for the oldest. Instead, the number of rounds in which a startup has participated, negatively affect the round amount, violating the findings by A.Conti (2017). Last, but not least since is the main purpose of Equation **(1)** and of this paper, we can observe that during the pandemic crisis the per round amount is, on average, higher than during normal times (41.5-42.7 percentage points more). This evidence provides support to our descriptive statistics findings, and the findings by Venture Pulse KPMG (2020), which assert that in 2020 the average amount per round is higher than it was in the past years, although the number of deals and the total amount of funding invested decreased. Therefore, it can be stated that VC industry is having a resilient behavior.

Table 5 shows the coefficients and standard errors (in parentheses) for two different specifications of Equation **(2)**. Column I reports the estimates of the corresponding equation, while column II includes the nonlinear effect of age on the round amount. In these regressions the coefficients of interest, since we are testing if the age increases during the pandemic, are the ones indicating the interaction between the variables $Covid\_Crisis_r$ and $Age_{j,r}$. As can be clearly seen the coefficients for this interaction term are both negative, which means that in 2020 older startups received, on average, less funding per round. These results can be interpreted by the fact that, during the pandemic, VCs have preferred to invest more money for younger new ventures because usually they are more adapted to deal with the problems associated with the COVID-19 outbreak. Indeed, newer firms are usually more flexible and technologic, and their operations as well, therefore by working remotely they can almost maintain their normal rate of productivity. Moreover, in the sample are included new established firms in the pharma industry which are focused on finding treatments for COVID-19 and developing a vaccine. Clearly, these new founded startups have attracted most of the funding, influencing the results of the regression considered.

Table 5
Covid crisis and startup per round amount: combined effect of age and pandemic

	Startup round amount (log)	
	(I)	(II)
Number of funds	0,1240***	0,1231***
	(0,0030)	(0,0030)
Round number	-0,0808	-0,0832
	(0,0032)	(0,0032)
Age at financing	0,0451***	0,1301***
	(0,0025)	(0,0070)
Age at financing^2		-0,0054***
		(0,0004)
Covid X Age	-0,0431**	-0,0327**
	(0,0049)	(0,0049)
Total funding to date (log)	0,7502***	0,7461***
	(0,0065)	(0,0064)
Covid Crisis	0,7127	0,6324
	(0,0390)	(0,0393)
Intercept	2,4279***	2,3041***
	(0,1067)	(0,1064)
Multiple R	0,7889	0,7921
R-squared	0,6224	0,6275
Adjusted R-squared	0,6222	0,6273
Standard Error	0,8906	0,8847
Observations	12555	12555

Table 5 presents OLS regression results for the amount of investment funds that a startup raised in a given round. Columns I and II report the coefficients for two different specifications of Equation **(2).** Each observation corresponds to a round *r* raised by a startup *j*. In columns I are reported the results for the basic Eq.**(2)**, column II includes the nonlinear effect of age on the round amount. The regressor of interest in this regression is the interaction between the variables Covid and Age. The definitions of all the variables are provided in **Table 3**. The standard errors are in parentheses. Significance noted as: *p < 0.10; **p < 0.05; ***p < 0.01.

In Panel A, B and C of **Tables 6**, are presented the results from estimating, respectively, Eqs. **(3)**, **(4)** and **(5)**. Panel A reports the coefficients and standard errors (in parentheses) for the natural logarithm of the startup round amount including the dummy $IT_{j,r}$, whereas Panel B and C provide the same results including, respectively, the dummies $NHT_{j,r}$ and $MHL_{j,r}$. In each panel, column I reports the estimates of the corresponding equation, while column II includes the nonlinear effect of age on the round amount.

Panel A shows that Information Technology startups receive 1.59% - 3.28% more funds than the startups belonging to other industry classes. During the pandemic crisis (2020), IT new ventures raised 0.39% - 3.53% more funding than they usually do during normal times. Panel B reveals that Non-High Technology firms generally raise 1.65% - 2.23% less per round funding than the other startups sectors. The results for this industry class are even worse during the COVID-19 outbreak, in fact, startups within this sector raised 8.58% - 10.42% less per round funds during 2020 than in normal periods. Finally, panel C shows that Medical/Health/Life Science startups usually receive 0.74% - 3.24% less than the other startups industry classes, but , as it is logical to think due to the fact that several new ventures are born with the aim of developing a vaccine, during the pandemic they raised 6.32% - 8.50% more than before the spread of COVID-19.

As can be clearly seen from **Table 6**, the impact of the pandemic on the per round funding has not been dramatic, with only the Non-High Technology industry class loosing funding per round (in percentage). What it might be state, from the evidence of the regression, is that Information Technology and Medical/Health/Life Science startups raised more per round funding during the COVID-19 outbreak period than in the past 5 years. The explanation for these results is different from one industry class to the other. The results for the Information Technology sector might be explained by the fact that startups belonging to this industry class are less affected by the pandemic. Indeed, for these new firms it is easier to work remotely and to deal with COVID-19 since the nature of their operations is already flexible and technologic. Medical/Health/Life Science startups, on the other hand, obtained better performance during 2020 due the fact that several companies born in this sector have the aim to develop a vaccine or different therapies to heal people affected by COVID-19.

Table 6

Covid crisis and startup per round amount: IT versus NHT versus MHL

Panel A: Information Technology	Startup round amount (log)	
	(I)	(II)
Number of funds	0,1243***	0,1232***
	(0,0030)	(0,0030)
Age at financing	0,0376***	0,1323***
	(0,0024)	(0,0070)
Age at financing^2		-0,0059***
		(0,0004)
Total funding to date (log)	0,7477***	0,7443***
	(0,0065)	(0,0064)
Covid Crisis	0,4016	0,4108
	(0,0396)	(0,0393)
Information Technology	0,0159**	0,0328**
	(0,0189)	)0,0188)
IT X COVID	0,0353*	0,0039*
	(0,0472)	(0,0469)
Round number	-0,0795	-0,0821
	(0,0032)	(0,0032)
Intercept	2,4960***	2,3211***
	(0,1085)	(0,1083)
Multiple R	0,7875	0,7914
R-squared	0,6201	0,6263
Adjusted R-squared	0,6199	0,6260
Standard Error	0,8933	0,8861
Observations	12555	12555

Panel B: Non-High Technology	Startup round amount (log)	
	(I)	(II)
Number of funds	0,1243***	0,1234***
	(0,0030)	(0,0030)
Age at financing	0,0374***	0,1312***
	(0,0024)	(0,0070)
Age at financing^2		-0,0059***
		(0,0004)
Total funding to date (log)	0,7474***	0,7437***
	(0,0065)	(0,0064)
Covid Crisis	0,4355	0,4219
	(0,0229)	(0,0227)
Non-High Technology	-0,0223**	-0,0165**

	(0,0287)	(0,0285)
NHT X COVID	-0,1042*	-0,0858*
	(0,0769)	(0,0763)
Round number	-0,0797	-0,0825
	(0,0032)	(0,0032)
Intercept	2,5154***	2,3589***
	(0,1066)	(0,1063)
Multiple R	0,7875	0,7914
R-squared	0,6202	0,6262
Adjusted R-squared	0,6200	0,6260
Standard Error	0,8933	0,8862
Observations	12555	12555

Panel C: Medical/Health/Life Science	Startup round amount (log)	
	(I)	(II)
Number of funds	0,1244***	0,1233***
	(0,0030)	(0,0030)
Age at financing	0,0374***	0,1324***
	(0,0024)	(0,0070)
Age at financing^2		-0,0059***
		(0,0004)
Total funding to date (log)	0,7474***	0,7438***
	(0,0065)	(0,0064)
Covid Crisis	0,4263	0,4067
	(0,0247)	(0,0246)
Medical/Health/Life Science	-0,0074**	-0,0324**
	(0,0214)	(0,0213)
MHL X COVID	0,0632*	0,0850*
	(0,0528)	(0,0524)
Round number	-0,0797	-0,0821
	(0,0032)	(0,0032)
Intercept	2,5161***	2,3588***
	(0,1067)	(0,1064)
Multiple R	0,7874	0,7913
R-squared	0,6201	0,6262
Adjusted R-squared	0,6199	0,6260
Standard Error	0,8934	0,8862
Observations	12555	12555

Table 6 presents OLS regression results for the amount of investment funds that a startup raised in a given round, divided by three different industry classes. Panel A focus on Information Technology (Equation **(3)**), while Panel B and Panel C focus on Non-High Technology and Medical/Health/Life Science, respectively (Eqs. **(4)** and **(5)**). Each

observation corresponds to a round *r* raised by a startup *j*. In columns I of each panel are reported the results for the basic corresponding equation, column II includes the nonlinear effect of age on the round amount. The definitions of all the variables are provided in **Table 3**. The standard errors are in parentheses. Significance noted as: *p < 0.10; **p < 0.05; ***p < 0.01.

7. Limitations and perspectives for the future

As we have seen in the previous section, the pandemic, against all odds, has positively affected the per round amount that startups raised during 2020. In particular, we have seen that Medical/Health/Life Science and Information Technology industry classes took advantage from the situation since they are more inclined to deal with the COVID-19 outbreak (IT sector) and/or gain profit from it (Medical/Health/Life Science sector). Indeed, VCs invested more per round funding than usual in new ventures belonging to the above-mentioned industry classes. We have also seen with the descriptive statistics of section 3, that the total amount of funding invested by VCs in startups in 2020 decreased if compared to 2019, but the number of deals decreased even more, increasing the average per deal amount. These results are consistent with the ones obtained with the regressions of this paper. By analyzing the data retrieved from Thomson Reuters Eikon database, one can state that the impact of the pandemic on the sector has been more moderate than in the dotcom bubble of 2001 and the financial crisis of 2007-2009, as predicted by the survey of 1,000 VCs mentioned in section 2 (Gompers et al., 2020). Nevertheless, the model of this paper has two main limitations. First, it is difficult to predict in only one year the real impact that the pandemic will have on the VC industry. Considering the financial crisis (2008) as a benchmark, we can state that we will not be able to analyze the final impact of the outbreak on the industry until the end of 2021. Indeed, when the financial crisis broke, the VC industry was not affected immediately but with a lag of about one year relative to the rest of the financial market (Bernstein et al., 2017). Second, the dummy variable $Covid\_Crisis_r$ is not statistically significant (p-value > 0.05) for all the regressions run in this paper. Therefore, there are strong evidences for the null

hypothesis, which means that the obtained coefficients of this variable are due to the chance of the sample.

As previously mentioned, after only one year from the COVID-19 outbreak, we are not able to perfectly predict its final impact on the VC industry. However, we can present the perspectives for the future of the industry. According to Stanfill, Stanford and Chao (2020), the outlook for the VC industry is clearer than in most of the other industries, with two sectors, tech and healthcare, receiving more funds during the pandemic than in the past. Moreover, VCs have abundant dry powder available to invest in startups and once they will finish their reserves, they will be able to raise new funds at historic low interest rates. Lastly, VC industry is living through a period of innovation and transformation, accelerated by the pandemic, increasing the access to capital for startups. Indeed, VCs are more and more adopting new types of investment vehicles and securities which in turn are enabling new ways to capitalize startups. In addition, the use of rolling funds by angel investors and the regulatory changes on crowdfunding are opening new sources of capital. Stanfill (2020) views all these factors as necessary and positive to foster the expansion of the industry.

In particular, the healthcare sector prospered in 2020 in terms of VC investments, boosted by the biotech and pharma industry which is focused on finding treatments for COVID-19 and developing a vaccine. Indeed, biotech and pharma startups received $23.2 billion from VC funds across 865 deals in 2020 (Stanford, 2020). Additionally, as opposite to tech companies, working remotely is almost impossible for employers in biotech and pharma industry, allowing firms within this sector to resume normal productivity sooner than most of the other industries. Therefore, as confirmed by the public market sentiment, we can predict that in 2021, and in the foreseeable future, this industry will still raise large amount of funding from VC funds.

8. Conclusion

This paper examines the impact of the pandemic on the Venture Capital industry and, in particular, its effect on VCs investment strategies. My paper addresses this question by focusing on three hypotheses: whether or not the pandemic is affecting the amount per round invested by VCs in US startups, whether VCs are investing in safer or in more innovative, but riskier, projects and whether the pandemic has a differentiated impact in different industries. First, my findings show that in 2020 the average amount per round raised by startups from VC funds is higher than it was in the past years, although the number of deals and the total amount of funding invested decreased. Second, they prove that, during the pandemic, VCs have preferred to invest more money for younger new ventures because usually they are more adapted to deal with the problems associated with the COVID-19 outbreak. Last, they reveal that Information Technology and Medical/Health/Life Science startups raised more per round funding during the pandemic period than in the past 5 years. Additionally, by examining the findings of Stanfill, Stanford and Chao (2020), we can predict that in 2021, and in the foreseeable future, the biotech and pharma industry will raise large amount of funding from VC funds. Moreover, we can predict that the VC industry will not be affected, from the pandemic, as most of the other industries, due to its flexibility and the fact that it is living through a period of innovation and transformation.

My findings are not exempt from limitations, therefore they are open to further research. First, the lack of viable instruments for the pandemic crisis limits our ability to perfectly predict the final impact of COVID-19 on the VC industry. Second, I only evaluate its impact on the per round amount, I neither examine the VCs exit strategy, nor their choices regarding their portfolio allocation. Last, my evidence regards investments made in US startups, hence one might examine VCs investments strategies in startups belonging to different parts of the world.

9. References

Alvarez-Garrido, Elisa. 2016. "How Do Vcs Foster Startup Innovation? VC Global Strategy And The Startup's Regulatory Uncertainty". *Academy Of Management Proceedings* 2016 (1): 16860. doi:10.5465/ambpp.2016.16860abstract.

Anari, Ali, and James Kolari. 1999. "Nonmonetary Effects Of The Financial Crisis In The Great Depression". *Journal Of Economics And Business* 51 (3): 215-235. doi:10.1016/s0148-6195(99)00005-3.

Archibugi, Daniele, Andrea Filippetti, and Marion Frenz. 2013. "Economic Crisis And Innovation: Is Destruction Prevailing Over Accumulation?". *Research Policy* 42 (2): 303-314. doi:10.1016/j.respol.2012.07.002.

Arnold, Paul. 2019. "There Are Only Three Venture Capital Strategies". *Forbes*, 15-18. https://www.forbes.com/sites/valleyvoices/2019/02/14/there-are-only-three-vc-strategies/?sh=18e811c054de.

Bernstein, Shai, Josh Lerner, and Filippo Mezzanotti. 2018. "Private Equity And Financial Fragility During The Crisis". *The Review Of Financial Studies* 32 (4): 1309-1373. doi:10.1093/rfs/hhy078.

Bianchi, Francesco. 2020. "The Great Depression And The Great Recession: A View From Financial Markets". *Journal Of Monetary Economics* 114: 240-261. doi:10.1016/j.jmoneco.2019.03.010.

Bonini, Stefano, and Vincenzo Capizzi. 2019. "The Role Of Venture Capital In The Emerging Entrepreneurial Finance Ecosystem: Future Threats And Opportunities". *Venture Capital* 21 (2-3): 137-175. doi:10.1080/13691066.2019.1608697.

Chu, Priscilla, and Robert D. Hisrich. 2001. "Venture Capital In An Economy In Transition". *Venture Capital* 3 (2): 169-182. doi:10.1080/13691060110042772.

Conti, Annamaria, Nishant Dass, Francesco Di Lorenzo, and Stuart J.H. Graham. 2019. "Venture Capital Investment Strategies Under Financing Constraints: Evidence From The 2008 Financial Crisis". *Research Policy* 48 (3): 799-812. doi:10.1016/j.respol.2018.11.009.

Ferrucci, Edoardo, Roberto Guida, and Valentina Meliciani. 2020. "Financial Constraints And The Growth And Survival Of Innovative Start-Ups: An Analysis Of Italian Firms". *European Financial Management*. doi:10.1111/eufm.12277.

Gompers, Paul A., Will Gornall, Steven Neil Kaplan, and Ilya A. Strebulaev. 2020. "Venture Capitalists And COVID-19."

Gornall, Will, Paul Gompers, and Steven Kaplan. 2020. "Venture Capitalists And COVID-19". *The Harvard Law School Forum On Corporate Governance*. https://corpgov.law.harvard.edu/2020/09/01/venture-capitalists-and-covid-19/#:~:text=The%20sudden%20arrival%20of%20the,choke%20off%20venture%20capital%20flow.&text=VCs%20report%20that%20during%20the,of%20their%20normal%2C%20expected%20activity.

Kang, Hyoung Goo, Rich M Burton, and Will Mitchell. 2012. "How Potential Knowledge Spillovers Between Venture Capitalists' Entrepreneurial Projects Affect The Specialization And Diversification Of VC Funds When VC Effort Has Value". *SSRN Electronic Journal*. doi:10.2139/ssrn.2148817.

Kharas, Adam. 2020. "The Triple Economic Shock Of COVID-19 And Priorities For An Emergency G-20 Leaders Meeting". *Brookings*. https://www.brookings.edu/blog/future-development/2020/03/17/the-triple-economic-shock-of-covid-19-and-priorities-for-an-emergency-g-20-leaders-meeting/.

Nanda, Ramana, and Matthew Rhodes-Kropf. 2011. "Financing Risk And Innovation". *SSRN Electronic Journal*, 1-24. doi:10.2139/ssrn.1657937.

"Refinitiv Eikon". 2020. *Eikon.Thomsonreuters.Com*. http://eikon.thomsonreuters.com/index.html.

Stanfill, Cameron, Kyle Stanford, and Joshua Chao. 2020. "2021 US Venture Capital Outlook Forecasting The Primary Trends That Will Shape The VC Industry In 2021". Pitchbook. https://pitchbook.com/news/reports/q4-2020-pitchbook-analyst-note-2021-us-venture-capital-outlook?utm_medium=nl-na&utm_source=reports&utm_campaign=q4-2020-pitchbook-analyst-note-2021-us-venture-capital-outlook&sourceType=NEWSLETTER.

Valliere, Dave, and Rein Peterson. 2005. "Venture Capitalist Behaviours: Frameworks For Future Research". *Venture Capital* 7 (2): 167-183. doi:10.1080/13691060500088076.